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As part of the DOD-MURI research program entitled "Modeling and control of Advanced Chemical Vapor Deposition Processes: the Control of Defects in Mixed III-V Compound Semiconductors"(Grant F49620-95-1-0447), DURIP funding was provided to establish a real-time optical characterization facility to study thin-film growth processes extended to super-atmospheric pressures. The extension of the chemical vapor deposition (CVD) to operating conditions at super-atmospheric pressures mandated validation of: (a) Simulations of surface reaction kinetics; (b) Simulations of homogeneous gas phase reactions coupled to transport in laminar high density vapor flows; and (c) the development of experimental methods for the detection of onset of turbulence, that is, verification of laminar flow under conditions of high pressure OMCVD.

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Final Technical Report

for the period

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Final Report for DURIP Contract No. F49620-99-1-0130

"Optical Diagnostics Systems Supplementing Integrated Materials Processing Facility of Major University Research Initiative"

(supplemental equipment grant to DOD-MURI Grant F49620-95-1-0447)

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As part of the DOD-MURI research program entitled "Modeling and control of Advanced Chemical Vapor Deposition Processes: the Control of Defects in Mixed III-V Compound Semiconductors"(Grant F49620-95-1-0447), DURIP funding was provided to establish a real-time optical characterization facility to study thin-film growth processes extended to super-atmospheric pressures. The extension of the chemical vapor deposition (CVD) to operating conditions at super-atmospheric pressures mandated validation of: (a) Simulations of surface reaction kinetics; (b) Simulations of homogeneous gas phase reactions coupled to transport in laminar high density vapor flows; and (c) the development of experimental methods for the detection of onset of turbulence, that is, verification of laminar flow under conditions of high pressure OMCVD.

The objective of the requested funding of a "Real-time optical characterization facility", was to establish spectroscopic diagnostic tools for molecular fragment specific process monitoring at sub-atmospheric pressure and to validate parameters used in process simulation and modeling for closed-loop control. For process parameter validation at high pressure, monitoring tools for near surface flow and epitaxial growth by principal angle spectroscopy (PARS) and Raman spectroscopy (RS) have to be established. Also crucial were the integration of line shape analysis of Rayleigh-Brillouin scattered light and flow visualization techniques as flow characterization techniques.

Efforts and Accomplishments:

The PI's at NCSU established a real-time optical characterization facility centered around a tunable laser system consisting of a 10 W pump laser, a Titanium Sapphire oscillator, a second/fourth harmonic generator and an optical parameter oscillator module. This configuration provides spectroscopic gas phase and materials analysis in the wavelength regime from 200nm to 1800nm, and 2.3 μm – 2.6 μm. The established tunable laser system is depicted in Figure 1. For the spectroscopic and molecular-specific analysis of molecular fragments in the gas phase as well as at the growth surface, we obtained a two-meter Czerney-Turner high-resolution scanning spectrometer. As depicted in Figure 2, the system includes an attached 0.2 m double-spectrometer for resonant Raman-spectroscopy. The detection system consists of a photo multiplier tube (PMT), a InGaSb Ir-detector, and a CCD camera system with imaging capabilities in the visible and near-IR regime.

Figure 1

Tunable laser-light source for spectroscopic gas phase and materials analysis in the wavelength regime from 200nm to 1800nm, and 2.3 μm – 2.6 μm (see text).

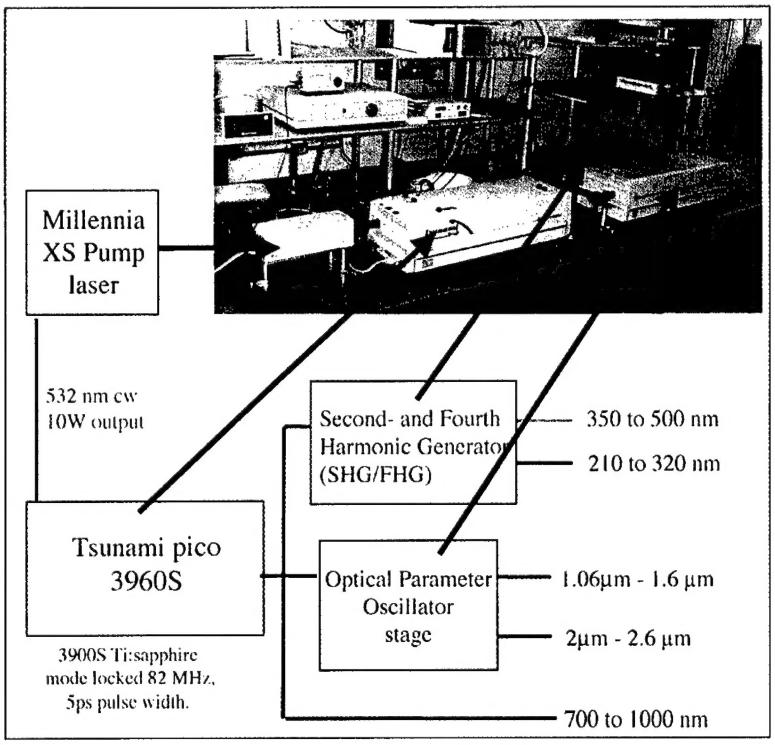

Figure 2:

High-resolution Czerney-Turner spectrometer with attached double-monochromator for Raman spectroscopy and high-resolution absorption spectroscopy in the UV- and IR wavelength regime.